

We conclude therefore:

1. That the halo in question was the rare $24^{\circ}34'$ halo listed in *Physics of the Air*, second edition, page 517.
2. That the cirrostratus cloud that produced it consisted largely of pyramidal crystals—probably stubby, truncated double right pyramids.
3. That the slope of the pyramid face to the longitudinal axis is very close to $24^{\circ}51'$, as computed in *Physics of the Air*.

Naturally one asks why the snow crystals in such large quantity had this unusual form. Possibly owing to the presence of minute quantities of some impurity, if one might so infer from the sensitivity, in many cases, of crystal form to foreign substances. But that is just a rational surmise. The problem is distinctly one for an interesting investigation.

THE WINTER OF 1932-33 AT FAIRBANKS, ALASKA

By R. L. FROST

[Weather Bureau Office, Fairbanks, Alaska, Nov. 16, 1933]

[Temperatures in degrees Fahrenheit]

At Fairbanks, Alaska, the first killing frost of the fall of 1932 occurred on September 1 and 3 weeks later the first snow fell. Ice began running in the Chena River on October 14 and the river froze over on the 31st. The first zero or subzero temperature also occurred on the 31st. From the 23d of October to the 14th of March the temperature remained below 32° , making 4 months and 3 weeks of continuous freezing weather. There were many days in September and October with freezing temperatures and snowfall, but in the interior of Alaska not that but the freezing over of the rivers is usually considered to mark the beginning of winter. In 1932 the Chena River at Fairbanks froze over on October 31 and the 5 following months are of considerable interest due to the extremely low temperatures recorded. The mean daily temperature during these 5 months was -8.7° . The first dogsled was seen on the streets October 27. It was about this time that airplanes operating over the airways of interior Alaska began using skii landing gear.

November began with a minimum temperature of 10° below zero and a maximum for the day of 5° above. The highest temperature for the month was 19° and the mean of 8.2° was 11.3° below normal. The highest barometric pressure, 30.55 inches, occurred on the 9th, and the lowest, 28.97 inches, on the 25th, the date also of the maximum temperature. November was the only month during the winter with a temperature of zero or below recorded every day. There were 13 days with maximum temperature below zero. Ice in the river averaged 25 inches in thickness at the end of the month, and just to show what late fall weather is like in the Alaskan interior, Dame Nature ushered it out with a minimum temperature of -30° . The maximum of the last day was 20° below zero.

December began with comparatively mild weather. A storm center moved in and the lowest barometric pressure, 29.11 inches, occurred on the 2d. The minimum temperature for the day was -12° . The low-pressure area moved out rapidly and on the 5th the barometer registered 30.94 inches—the highest for the month. On that day the temperature dropped to 39° below zero. However, it was not until the 23d that unusually cold weather prevailed. From that date to the end of the month the mean temperature was -33.8° . The maximum temperature for the month was 27° on the 9th. There were 30 days with minima zero or lower, and on 14 days the maxima were below zero. The mean temperature for the month was -13.1° which is 6.9° below normal. During the last 6 days the total wind movement was but 15 miles, and on the 28th every hour of the day was calm. Ice in the river averaged 37 inches thick at the end of the month.

On December 21 the time of sunrise was 9:58 a.m. and sunset, 1:38 p.m., giving 3.7 hours of possible sunshine.

The altitude of the sun at noon was $1^{\circ}42'$. At 10 a.m. the brightest stars were visible in the western sky. On June 21 sunrise was at 12:56 a.m. and sunset at 10:50 p.m., giving 21.9 hours of possible sunshine and 24 hours of daylight. The old year was ushered out with a temperature of 47° below zero and a maximum for the day of 41° below.

December had been a very cold month but it proved to be a mere sample of what was to come in January. Those who attended the New Year's dance did not loiter long on the streets as the minimum temperature on the 1st was -42° and the highest during the day -38° . The cold spell which began on December 23 continued until January 9, a total of 18 days, during which time the temperature was never above zero. The mean temperature for this period was -35.2 . When the cold spell broke the temperature rose from -41 on the 9th to 12° on the 10th. Mild weather prevailed from the 9th to the 23d and during this period 17.8 inches of dry, powdery snow fell. On the 23d day a severe cold wave began and continued to the end of the month. For this period (24th to 30th) the temperature averaged -41.1 . The 27th was a very cold day with a maximum of -44° and a minimum of -57° , but on the following day the thermometer reached 60° below zero, a point which was equaled in 1916 but has not been exceeded for 22 years. At 2 p.m. the temperature rose to -47° which was the maximum for the day. For two periods of 14 hours each the temperature ranged between 55° and 60° below zero. It was then that many people who ventured outdoors had the unique and eerie sensation that occurs when one can hear his breath freeze. As usual on very cold days a dense ground fog prevailed over the city. On this occasion the dense fog persisted for 53 hours. The mean temperature for the month was -23.5° which is 13.2° below normal. There were 21 days with maximum and 28 days with minimum temperatures zero or lower. Starting on the 27th and ending on the 29th there was a period of 46 consecutive hours of calm.

Whenever the temperature reached -42° a dense ground fog almost invariably formed over the city. The fog persisted and thickened as the temperature dropped lower and continued until the thermometer rose to about -38° at which point it thinned out to some extent. The highest temperature at which dense fog prevailed was -37° . There were 12 days with minimum temperature -42° or lower. Dense fog occurred on 10 of these days. Light fog was noted on 5 other days. It was interesting to observe the manner in which the fog froze and formed frost crystals on all exposed objects. The telephone wires, trees, and fences became festooned with frost flowers and were very picturesque. This coating of ice flowers often formed an inch or more in thickness and

remained until shaken off by the rapid vibrations of the wires or was blown off the trees by the wind. The layer of fog was shallow, often only 40 or 50 feet thick. On the streets visibility was restricted to 50 yards while, from the observation platform on the roof, Mt. McKinley, 160 miles away, often was visible. Ice in the river averaged 43 inches thick on the 31st of January. It is interesting to note that Admiral Byrd, in his book "Little America" mentions but 2 months with mean temperatures lower than the January mean at Fairbanks.

February began with mild weather and a low barometer. The maximum temperature of 28° occurred on the 8th and the minimum -49° on the 23d. A great high-pressure area extended over the interior of Alaska late in the month. On the 27th the barometer reached 31.09 inches and remained above 31 inches for 26 hours. The minimum temperature at this time was -45° and the maximum -22°. On 12 days the maximum was zero or lower and on 20 days the minimum was below zero. The average temperature for the coldest 7-day period was -18°. The mean for the month was -6.8° which is 6.9° below normal. Ice in the river averaged 53 inches in thickness at the close of the month.

The cold wave which began on February 18 continued over into March. The minimum temperature for the month, -35°, occurred on the 1st. The mean for the month, 8.3°, is 2° below normal. On the 14th the temperature rose above 32° for the first time since October 23. The barometer fell to 28.97 inches on the 15th and the temperature went up to 45°. Six days previous the barometer registered 30.8 inches. When the storm center arrived the temperature rose from -15° on the 14th to 45° on the 15th. Ice in the river averaged 56.5 inches in thickness on the 13th of March, which is the greatest thickness ever recorded at this station. The mean temperatures for the past 5 months had now been -8.7 and for the past 6 months, -2.4°.

The minimum temperature for April was -5° and the mean 32.1°. The hours of sunlight on the 1st amounted to 13.6 and on the 30th to 16.9. The snow now slid off the house tops and that on the ground began melting. The top layer of soil began thawing and pools of icy water covered the land. The last dogsled was seen on

the streets April 19 and this was also the date the first airplane had the skii landing gear removed and began operating on wheels. Winter was over. Late in April the mosquitoes began to appear. Migratory birds were first observed on May 3. Pussy willows appeared and a few crocus and other flowers were observed May 1. The ice broke up in the Tanana River on May 8. Buds on the deciduous trees began opening May 22, and the last heavy frost of spring occurred on June 9.

Record of daily minimum temperatures during the 5 winter months of 1932-33

Number of days	32° or lower	20° or lower	10° or lower	0° or lower	-10° or lower	-20° or lower	-30° or lower	-40° or lower	-50° or lower	-60°
November.....	30	30	30	30	23	12	2			
December.....	31	31	30	30	22	14	12	4		
January.....	31	30	28	28	26	24	20	15	3	1
February.....	28	27	27	21	15	13	11	6		
March.....	31	29	26	20	14	7	2			
Total days.....	151	147	141	129	100	70	47	25	3	1

Comparative monthly temperatures for Alaska and for selected stations in Canada and northern United States during the winter of 1932-33

	November			December			January			February			March			5 months
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	
Greenville, Maine.	54	-3	34.9	51	-10	23.6	42	-9	22.1	44	-11	19.5	46	-6	22.4	24.6
Boston.....	66	8	42.8	66	0	38.1	60	9	37.8	66	9	33.7	60	11	35.7	37.6
Albany, N.Y.....	58	9	37.8	63	-7	31.8	56	5	34.6	57	3	29.1	57	8	33.0	33.3
Washington.....	68	18	44.7	68	14	39.6	68	20	42.6	68	14	38.4	74	20	43.0	41.7
Chicago.....	63	17	37.2	58	-4	28.8	57	16	36.7	56	-19	26.2	69	6	35.4	32.9
Duluth.....	62	-10	25.7	45	-23	12.0	42	-15	17.6	39	-33	6.8	44	-13	24.0	17.2
Devils Lake.....	51	-10	23.6	48	-20	11.0	39	-13	9.5	44	-35	5.8	60	-8	25.8	15.1
Havre.....	80	-10	31.6	54	-30	19.8	53	-21	21.6	59	-32	16.0	68	-16	35.0	24.8
Miles City.....	60	-3	34.5	66	-26	17.0	67	-23	20.4	48	-35	15.3	70	6	37.1	24.9
Yellowstone Park.	53	4	32.2	43	-29	11.9	37	-7	19.2	37	-40	10.2	51	0	28.4	20.4
Grand Junction.....	61	15	39.3	51	0	22.9	44	-6	20.2	55	-21	16.5	74	22	43.9	28.3
Spokane.....	58	26	42.0	54	1	26.9	48	11	31.8	46	-17	23.3	57	23	40.2	32.8
Doucet, Quebec.	44	-35	17.5	41	-48	8.2	36	-44	7.0	35	-52	2.9	45	-36	12.8	9.7
Cochran, Ontario.	46	-12	20.8	47	-27	11.0	34	-29	6.2	34	-33	5.7	42	-16	15.4	11.8
Le Pas, Manitoba.	50	-25	11.0	33	-32	-3.5	36	-38	-7.6	36	-40	-6.3	52	-28	11.6	1.0
Prince Albert,																
Saskatchewan	51	-12	15.9	38	-31	2.2	38	-38	-4.0	43	-40	-1.7	44	-33	15.7	5.6
Winnipeg.....	46	-20	18.5	39	-34	2.7	33	-31	2.3	39	-42	-1.9	48	-19	17.1	7.7
Juneau.....	43	11	31.8	40	9	27.1	45	7	24.0	42	13	28.6	49	9	32.6	28.8
Nome.....	35	-13	6.0	39	-22	13.2	28	-36	-6.7	39	-28	2.6	28	-22	7.2	4.5
Fairbanks.....	19	-30	-8.2	27	-47	-13.1	17	-60	-23.5	28	-49	-6.8	45	-35	8.3	-8.7

TWO GOOD BOOKS ON METEOROLOGY

- (1) *The Drama of the Weather*, by Sir Napier Shaw, Cambridge University Press, 1933.
- (2) *A Short Course in Elementary Meteorology*, Fourth edition (completely revised), by W. H. Pick, London: His Majesty's Stationery Office, 1933.

(1) Naturally the publishers of Sir Napier Shaw's great 4-volume Manual of Meteorology, written for the High Priests, were insistent that he produce something inspiring for the layman. That is why "The Drama of the Weather" came to be written, a finely printed, beautifully illustrated book cram-full of information with here and there a touch of delightful humor. And with all its world of facts there is in this book neither *sin* nor *cosin* from cover to cover, nor any other mathematical symbol or function whatsoever. What a delight it is to the novice, and yet a store of knowledge on which even the longest initiated can draw with pleasure and profit.

(2) The second of these books is an old and honored friend from the Meteorological Office, London, grown a bit more portly from attending every new banquet worth while. On this fourth visit he tells us all he did before, concisely and accurately, and adds something besides, especially in regard to map construction and forecasting. One can see, too, that here he wisely follows the biblical injunction: "Prove all things: hold fast that which is good."

Nor does this friend, either, puzzle us with mathematical equations, save a few of the simplest that he just has to use when talking about the upper air—that is another reason, in addition to reliability, why he is welcome everywhere.—W. J. H.